On the Functions of the Glands of the Digestive Apparatus of Insects. By M. Jousset.

The physiological functions of the glands of the digestive apparatus of insects have not yet been determined with sufficient certainty; hence the differences of opinion that exist in science as to the part to be attributed to each of these glands in the digestion of food.

The naturalists who have paid attention to this subject have almost always made use in their researches of the liquid contents of the digestive tube; and I have thought that the different results at which they have arrived were to be ascribed to this very defective practice, since these liquids are complex and mixed in always unknown proportions. I have therefore sought amongst the various insects for one in which the arrangement of the glandular organs might enable me to collect these liquids in the gland itself, before their entrance into the digestive tube.

The cockroach (*Blatta orientalis*) is in this case. The three glandular groups of its digestive apparatus are very favourable to experiment and arranged as follows: the upper region, consisting of an œsophagus, a crop, and a trituratory apparatus, bears œsophageal glands in bunches, called *salivary glands*, nearly 1 centim. in length; the middle region or stomach presents eight glandular cæca, 4 or 5 millims. in length; and, lastly, the lower region, or intestine, bears Malpighian tubes which are easily isolated. These three glandular apparatus occur in all insects; but they vary much in dimensions, and are usually too small to enable us to collect the contents in a state of purity. The cockroach thus forms a fortunate exception.

By experimenting with these liquids collected before their entrance into the digestive tube, I have been able to ascertain that the sole agent in the digestion of amylaceous matters is the secretion-product of the œsophageal or salivary glands. I have convinced myself, by direct experiment, that none of the other glands possesses a marked action upon amylaceous substances, and that the secretion-product of the salivary glands has no action upon the albumenoid and fatty foods. I think that the digestion of feculent substances takes place principally in the crop in those insects which have the œsophageal glands greatly developed, like the cockroach—and that when these glands are small and lodged in the walls of the œsophagus, this digestion, which in this case is of little importance, takes place in the stomach. The glucose produced is absorbed by the stomach and does not pass into the intestine.

The cæca which surround the stomach are endowed with quite different properties. They secrete a yellowish liquid, which is feebly but distinctly acid. After collecting a sufficient quantity, I ascertained that, as already stated, it has no action upon amylaceous matters, but that it dissolves with remarkable energy the albumenoid substances, coagulated albumen, caseine, and in particular fibrine, of which it rapidly liquefies as much as twice its own volume. I

have also ascertained that the albumenoids were not simply dissolved, but transformed into true peptones, no longer coagulable by heat or by acids, but only by bichloride of mercury.

The liquid of the cæca further possesses the property of energetically emulsionizing fats, a property which is not shared either by the salivary glands or by the Malpighian tubes. This emulsion lasts for a very long time and acquires a marked acidity.

We see, therefore, that in a general way the product of the gastric cæca constitutes the most important agent of digestion in insects; and those of them which, like the herbivorous insects, feed upon substances difficult of digestion, possess innumerable gastric cæca and have at their service a great quantity of this liquid. This property of emulsionizing and acidifying fatty matters, which the gastric juice of the Vertebrata does not possess, appears to approximate this product of secretion to the pancreatic juice; and the assimilation would be complete if it applied also to the amylaceous substances; but we have seen that this function belongs exclusively to the œsophageal glands in the digestion of insects. Nevertheless, taking into consideration the weak acidity of the liquid of the cæca and its action upon fats, I incline to regard it as presenting much analogy with the pancreatic juice, the character of the action upon starches not being primordial in the pancreas, as M. Claude Bernard has demonstrated that, in certain fishes, this organ is already destitute of action upon amylaceous matters.

However this may be, I believe that the peptones formed in the stomach and the fatty emulsions are absorbed at once by the walls of the stomach, which is the essential part of the digestive apparatus and plays the double part of the stomach and the small intestines of the Vertebrata. The materials which have resisted these actions, and which are consequently unfit for digestion, alone pass into the intestine, which I regard as playing scarcely any part in digestion properly so called.

The Malpighian tubes in these researches have always offered clearly negative characters. Their product of secretion does not act upon amylaceous substances, or upon albumenoids, or upon fatty matters. This confirms the opinion generally adopted that this group of glands is purely and simply an organ of excretion, a urinary organ probably more complete than that of the Vertebrata, since it is the sole eliminating organ of insects. The presence here of uric acid and of urates has long since been ascertained; but perhaps they furnish other principles analogous to the excrementitial matters that the liver has to eliminate in the Vertebrata.

These researches confirm the opinion long ago maintained by M. Blanchard as to the very high grade that insects should occupy in the animal series. We see, in fact, that their digestive functions greatly approximate to those of the higher Vertebrata.—*Comptes Rendus*, January 3, 1876, p. 96.